Section 1

CONTENTS

Comprehensive Remedial Investigation/Feasibility Study for Waste Area Group 6 and 10 Operable Unit 10-04

1. INTRODUCTION

This report will present the development and results of the Operable Unit (OU) 10-04 remedial investigation/feasibility study (RI/FS). The Federal Facility Agreement and Consent Order (FFA/CO) (Department of Energy Idaho Operations Office [DOE-ID] 1991) requires evaluation of the Idaho National Engineering and Environmental Laboratory (INEEL) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 United States Code [USC] § 9601 et seq.). An FFA/CO requirement is the completion of the OU 10-04 RI/FS for Waste Area Groups (WAGs) 6 and 10. The WAG 6 comprehensive RI/FS (OU 6-05) will be incorporated into this RI/FS in accordance with the FFA/CO (DOE-ID 1991).

The FFA/CO states that WAG 10 includes miscellaneous surface sites and liquid disposal areas throughout the INEEL that are not included within other WAGs. WAG 10 also includes regional Snake River Plain Aquifer concerns related to the INEEL that cannot be addressed on a WAG-specific basis. The boundary of WAG 10 is the INEEL boundary or beyond, as necessary, to encompass real or potential impact from INEEL activities, and areas within the INEEL not covered by other WAGs. WAG 6 consists of the Experimental Breeder Reactor No. I (EBR-I) and Boiling Water Reactor Experiment (BORAX) areas.

The FFA/CO described WAG 10 as a "safety net," referred to the OU 10-04 RI/FS as the "blanketing" INEEL-wide cumulative RI/FS, and specified that the OU 10-04 RI/FS would follow all other INEEL WAG-specific RI/FSs. The FFA/CO (DOE-ID 1991) stated that a draft RI/FS for WAGs 6 and 10 was due to the agencies for review in July 2000.

Since the initial signing of the FFA/CO agreement, several new sites and a facility assessment for EBR-I have been identified. The new sites include BORAX-08, BORAX-09 (OU 6-02), Security Training Facility (STF)-01, STF-02 (OU 10-04), miscellaneous ordnance sites (OU 10-05), and the telecommunications cable (OU 10-07). In addition, OU 10-06 investigated several sites at other WAGs. This OU was never officially added to the FFA/CO, and the final disposition of sites placed under this OU is discussed in Section 3. BORAX-08, BORAX-09, and OU 10-07 were not officially added to the FFA/CO, but will be evaluated in the OU 10-04 RI/Baseline Risk Assessment (BRA).

The scope of WAG 10 has also expanded from the original FFA/CO concept. Several sites have been passed from other WAGs to the OU 10-04 RI/FS because of ecological or other concerns. The need for an evaluation of risk to Native Americans was identified. Other changes in scope and schedule have resulted in creation of an OU (OU 10-08) to WAG 10, which changed the OU 10-04 scope and extended the schedule for a draft RI/FS to the agencies for review to June 2001. These changes are documented in letters OPE-ER-83-99 and OPE-ER-90-99, and the scope of these changes is discussed in Section 1.2.

1.1 Purpose

The OU 10-04 RI/FS is a cumulative and comprehensive process that summarizes previous investigations and completes additional studies to ensure the overall risk posed by historical operations is accurately assessed. This process will be conducted by reviewing previous investigations, assessing new sites, reviewing interim and removal actions, evaluating residual risk, and evaluating the cumulative risk.

The overall objectives of a BRA are to help determine whether additional response action is necessary, to provide a basis for determining residual contaminant levels that are adequately protective, to provide a basis for comparing impacts of various remedial alternatives, and to help support selection of the "no-action" remedial alternative (where appropriate) (EPA 1989). The purpose of the feasibility study is to develop an appropriate range of remedial alternatives, screen these alternatives, and provide a detailed analysis of applicable alternatives.

Specifically, the OU 10-04 comprehensive RI/FS will

- Determine the nature and extent of contamination associated with the WAGs 6 and 10 sites of concern identified for quantitative evaluation in the OU 10-04 comprehensive RI/BRA by the OU 10-04 Work Plan (DOE-ID 1999).

- Determine the nature and extent of contamination associated with new WAG 10 sites identified for quantitative evaluation in the OU 10-04 comprehensive RI/BRA.

- Determine the nature and extent of contamination associated with those sites passed to WAG 10 from other facilities for quantitative evaluation in the OU 10-04 comprehensive RI/BRA.

- Determine site-specific contaminant transport through review of past investigations and the results of planned field activities at sites of concern.

- Determine site-specific exposure routes and pathways for sites of concern.

- Estimate the current and future cumulative and comprehensive baseline risk to human health and the environment posed by contaminants of concern (COCs).

- Evaluate the risk to INEEL-wide ecological receptors.

- Include a report written by the Shoshone-Bannock Tribes containing their findings at the OU 10-04 sites of concern. This report is included in its entirety as Appendix A. References to the tribal report are included under the specific OU 10-04 site discussions.

- Conduct literature searches and interviews and review the results of past investigations to develop and evaluate candidate remedial technologies for OU 10-04 sites for the RI/FS.

- Develop preliminary remediation goals (PRGs) and remedial action objectives (RAOs) based on risk, and evaluate the appropriate remedial action alternatives based on the nine CERCLA criteria (42 USC § 9601 et seq.).

1.2 Scope

The RI/FS report is presented in two stages: (1) an RI, which includes the BRA, and (2) an FS for those sites identified in the RI that represent a risk to human health and the environment. The OU 10-04 RI/FS scope will include:

- Evaluation of the risks and remedial alternatives for the WAG 6 and 10 sites

- Evaluation of the risks and remedial alternatives for the STF

- Evaluation of the sitewide ecological risks and remedial alternatives
- Evaluation of the risks and remedial alternatives for the ordnance sites
- Evaluation of the risks to Native American stakeholders
- Evaluation of new sites passed to WAG 10 as of June 29, 1999 (OPE-ER-90-99).

As discussed in the introduction, OU 10-04 responsibilities discussed in the FFA/CO were modified by the inclusion of OU 10-08. The OU 10-08 RI/FS scope will include the evaluation of the INEEL sitewide groundwater concerns, the evaluation of new sites that are passed to WAG 10 by other WAGs, and the evaluation of new sites that are discovered after the OU 10-04 RI/FS process is completed. OU 10-08 may also be responsible for characterizing and performing necessary remedial activities at new sites discovered inside the boundaries of WAGs 1 through 7. The WAG that discovers the site, with the concurrence of the agency remedial project managers, will be responsible for deciding whether the site will be referred to WAG 10, completing the new site identification process, and providing appropriate notifications that the site will be added to OU 10-08.

The exception to this rule applies to sites that have the same nature of contamination (such as radionuclide-contaminated soil) as other sites that are already being addressed by a WAG. If a WAG Record of Decision (ROD) has already evaluated all of the remedial alternatives that are appropriate for the new site, the new site may be retained by the affected WAG. A fact sheet, explanation of significant differences, or ROD amendment, whichever is appropriate, would be prepared by the WAG to cover investigation and remediation of the new site. If the previously evaluated alternatives are not appropriate for the new site, the agency remedial project managers will decide whether the site will be retained for a new evaluation of alternatives or referred to OU 10-08.

1.3 Regulatory Background

In January 1986, hazardous waste disposal sites within the INEEL that might pose an unacceptable risk to human health and safety or the environment were identified in the results of an INEEL assessment (EG&G 1986). The INEEL assessment was the first step in a structured program developed by the U.S. Department of Energy (DOE) through DOE Order 5480.14 that investigated past disposal operations for facilities under their control. The sites were ranked using either the U.S. Environmental Protection Agency (EPA) hazard ranking system for sites with chemical contamination or DOE modified hazard ranking system for sites with radiological contamination. A score of 28.5 or higher in either category qualifies a site for the National Priorities List (NPL) as amended by CERCLA (42 USC 9601 et seq.). Because several sites within the INEEL received scores in excess of 28.5, the entire INEEL became a candidate for the NPL.

On July 14, 1989, the EPA proposed placing the INEEL on the NPL of the *National Oil and Hazardous Substances Contingency Plan* (NCP) (40 Code of Federal Regulations [CFR] 300). The EPA Region 10 (with public participation during a 60-day comment period following the proposed listing) issued a final rule on November 21, 1989, that listed the INEEL on the NPL (54 Federal Register [FR] 48184). As a federal facility, the INEEL is eligible for the NPL pursuant to NCP requirements in 40 CFR 300.66(c)(2).

The FFA/CO (DOE-ID 1991) establishes the procedural framework and schedule for response actions at the INEEL in accordance with the CERCLA, the Resource Conservation and Recovery Act of 1980 (RCRA) (42 USC 6901 et seq.), and the *Idaho Hazardous Waste Management Act* (Idaho Code 39-4401 et seq.). The FFA/CO; signed by DOE-ID, EPA Region 10, and the State of Idaho; identifies

10 WAGs at the INEEL. The *Action Plan* of the FFA/CO categorizes the WAGs 6 and 10 sites into five OUs each. Since the signing of the FFA/CO, additional sites and OUs have been added to WAGs 6 and 10 (see Section 3).

1.4 Report Organization

This document is designed as a handbook for describing sites, evaluating sampling data, contaminants, sources, and remaining data gaps. It presents the results of investigations that support the development of remediation strategies. It also includes the final conceptual site model (CSM), human health and ecological risk assessments (ERAs), RAOs, and applicable or relevant and appropriate requirements (ARARs). The following items briefly describe the sections and appendices of this document:

- Section 2—Details the general site background and physical descriptions addressing the INEEL as well as OU 10-04 site locations and descriptions, physical characteristics, cultural resources, flora and fauna, demography, and land use. Specific subsections of physical characteristics address physiography, meteorology, climatology, surface water, and groundwater.

- Section 3—Is an overview of the historical site activities, including the sites of concern identified in the OU 10-04 work plan. This section details an additional screening process that eliminated several sites and includes the final list of sites evaluated in the BRA.

- Section 4—Is the summary of the chemical (including radiological) screening methodology for human health as well as the ecological chemicals of potential concern. It includes the BRA methodology for human health and ecological receptors. This also includes a summary of the Native American qualitative risk assessment.

- Sections 5 through 16—Detail the retained sites in WAGs 6 and 10. The retained sites are EBR-03, EBR-04, EBR-I, BORAX-02, BORAX-01, BORAX-08, BORAX-09, EBR-08, EBR-09, EBR-10, EBR-11, EBR-12, EBR-15, Liquid Corrosive Chemical Disposal Area (LCCDA)-01, LCCDA-02, Organic-Moderated Reactor Experiment (OMRE)-01, ORD-01 through ORD-29 Ordnance Areas, STF-01, STF-02, Idaho Nuclear Technology and Engineering Center (INTEC) fly ash pit, OU 10-06 radionuclide contaminated soil, and the OU 10-07 buried telecommunications cable. Each section includes subsections for site description, previous investigations, nature and extent of contamination, risk assessment for human health, ecological receptors and Native American resources, uncertainties, conclusions, and recommendations.

- Section 17—Summarizes the OU 10-04 sitewide ERA.

- Section 18—Summarizes the RI/BRA and states conclusions.

- Section 19—Describes the development of RAOs and response actions.

- Section 20—Describes the development of alternatives.

- Section 21—Details the screening of alternatives.

- Section 22—Contains a thorough analysis of these alternatives.

- Appendix A, Shoshone-Bannock Tribal Report.
- Appendix B, Site Background and Physical Characteristics of the INEEL.
- Appendix C, Data Summary.
- Appendix D, Human Health Risk Assessment Methodologies.
- Appendix E, Input Tables for the Human Health Risk Assessment.
- Appendix F, WAGs 6 and 10 Ecological Risk Assessment.
- Appendix G, Input Tables for the Ecological Risk Assessment.
- Appendix H, Operable Unit 10-04 Ecological Risk Assessment.
- Appendix I, Cost Estimates to Support the Feasibility Study.
- Appendix J, FY 99 and FY 00 Field Activities.
- Appendix K, Development of Lead Preliminary Remediation Goals (PRGs) for ecological receptors using a Monte Carlo approach, and arsenic background evaluation.
- Appendix L, Analysis of risk from to groundwater from EBR-I using RBCA, and analysis of risk from BORAX-02 using Microshield.
- Appendix M, Groundwater modeling results for the Juniper Mine.

1.5 References

40 CFR 300, Title 40, "Protection of Environment," Chapter 1, "Environmental Protection Agency," Part 300, National Oil and Hazardous Substance Pollution Plan, *Code of Federal Regulations*, current issue.

54 FR 48184, 40 CFR 300, "Environmental Protection Agency National Priorities List of Uncontrolled Hazardous Waste Sites," *Code of Federal Regulations,* Final Rule.

42 USC § 6901 et seq., October 21, 1976, "Resource Conservation and Recovery Act (Solid Waste Disposal Act)," *United States Code.*

42 USC § 9601 et seq., December 11, 1980, "Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/Superfund) of 1980," *United States Code.*

DOE-ID, April 1999, *Work Plan for Waste Area Groups 6 and 10 Operable Unit 10-04 Comprehensive Remedial Investigation/Feasibility Study*, DOE/ID-10554.

DOE-ID, 1991, *Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory*, 1088-06-29-120, U.S. Department of Energy Idaho Operations Office, U.S. Environmental Protection Agency, Region 10; State of Idaho, Department of Health and Welfare.

EG&G, January 1986, *Installation Assessment Report for EG&G Idaho, Inc.*, Operations at Idaho National Engineering Laboratory (Informal Report), EGG-WM-6875.

EPA, December 1989, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*, Interim Final Office of Emergency and Remedial Response, U. S. Environmental Protection Agency, EPA/540/1-89/002.

Idaho Code 39-4401 et seq., "Hazardous Waste Management Act of 1983," Title 39, "Health and Safety," Chapter 44, "Hazardous Waste Management."

Letter dated June 10, 1999, from K.E. Hain, DOE-ID, to W. Pierre, EPA, and D. Nygard, IDHW; Subject: Request for Extension of the WAG 10-04 RI/FS Schedule and Addition of New Operable Units titled OU 10-08 and OU 10-09 (OPE-ER-83-99).

Letter dated June 29, 1999, from K.E. Hain, DOE-ID, to W. Pierre, EPA, and D. Nygard, IDHW; Subject: Request for Extension of the WAG 10-04 RI/FS Schedule and Addition of a new Operable Unit titled WAG 10-08 (OPE-ER-90-99).

Section 2

CONTENTS

2. SUMMARY OF THE SITE BACKGROUND AND PHYSICAL CHARACTERISTICS OF THE INEEL

The complete site background and physical characteristics of the INEEL (including all references) that are represented by this summary are found in Appendix B of this RI/FS.

2.1 Site Background and History

The INEEL is a government-owned reservation managed by DOE. The INEEL Site occupies approximately 2,305 km^2 (890 mi^2) of the northern portion of the Eastern Snake River Plain (ESRP).

During World War II, the U.S. Navy and U.S. Army used a large portion of the area that is now the INEEL as a gunnery and bombing range. In 1949, the U.S. Atomic Energy Commission (AEC) established the National Reactor Testing Station (NRTS) on the Site. The NRTS was renamed twice: first as the Idaho National Engineering Laboratory (INEL) in 1974, and then as the INEEL in 1997. The U.S. Bureau of Land Management (BLM) controlled the land before the NRTS was established.

Public land orders in the 1940s withdrew the land from the public domain. Since 1957, one-third of the INEEL has been excluded from public access and has been relatively undisturbed. Currently, over half of the INEEL is open to grazing through BLM-administered permits. The Sagebrush Steppe Ecosystem Reserve at the INEEL was created in July 1999, by the DOE, the U.S. Fish and Wildlife Service, the Idaho Fish and Game Department, and the BLM. These agencies recognized that the INEEL has been a largely protected and secure facility for 50 years and that there is value in maintaining this endangered ecosystem.

2.2 Physiography

The INEEL is located on the northern edge of the ESRP, a northeastern-trending basin, 80 to 110 km (50 to 70 mi) wide. The Snake River Plain (SRP) is the largest continuous physiographic feature in southern Idaho. This large topographic depression extends from the Oregon border across southern Idaho to Yellowstone National Park in Montana and northwestern Wyoming. Three mountain ranges end at the northern and northwestern boundaries of the INEEL: (1) the Lost River Range, (2) the Lemhi Range, and (3) the Beaverhead Mountains of the Bitterroot Range.

2.3 Meteorology and Climatology

The National Oceanic and Atmospheric Administration (NOAA) and its predecessor have operated meteorological observation programs at the INEEL since 1949. The NOAA staff makes a full range of hourly and daily meteorological observations.

These observations are useful because atmospheric transport of contaminants is controlled by particle size, climate, local meteorology, local topography and large structures or buildings on-Site, and contaminant source strength.

The local topography, mountain ranges, and large-scale weather systems influence the local meteorology. The orientation of the bordering mountain ranges and the general orientation of the ESRP play an important role in determining the wind regime. The INEEL is in the belt of prevailing westerly winds, which are normally channeled across the ESRP. This channeling usually produces a west-southwesterly or southwesterly wind. The greatest frequency of high winds occurs in the spring (Clawson et al. 1989). The INEEL is subject to severe weather. Thunderstorms are observed mostly during the spring and summer, with an average of two to three thunderstorms a month occurring from June through August. Thunderstorms accompanied by strong, gusty winds may produce local dust storms that could mobilize contaminants. Occasionally, a single thunderstorm will exceed the average monthly total precipitation (Bowman et al. 1984). Precipitation from thunderstorms at the INEEL is generally light. Dust devils, common in the region, can entrain dust and pebbles and transport them over short distances. They usually occur on warm sunny days with little or no wind. The dust cloud may be several hundred meters (yards) in diameter and extend several tens of meters (hundred feet) into the air (Bowman et al. 1984).

Contaminant resuspension due to range fires has not been considered, because based on previous studies, actual remediation efforts (i.e., trucks moving across the surface) allow for the greatest amount of contaminant dispersion due to wind action. Because the worst case scenario for surface contamination has been addressed, range fires will not be addressed.

2.4 Geology

Within the ESRP region, which includes the Yellowstone Plateau and the northern Basin and Range Province that flanks the plain, several geologic processes may affect the choice of remedial alternatives for the WAG 10 and WAG 6 sites: subsidence of the plain itself, faulting in the northern Basin and Range Province, and volcanism on the plain.

The geologic events that gave rise to the ESRP also produced the Snake River Plain Aquifer (SRPA). The SRPA is a world-class aquifer in terms of the volume and the quality of groundwater. It is also classified as a sole source aquifer by the EPA. The natural setting of most of the watershed, the lack of large urban or industrial areas in the ESRP, and the absence of soluble materials in the geologic units encountered by aquifer waters all contribute to the purity of the SRPA. Historically, the major threats to the aquifer have been agricultural activities such as pumping for irrigation and fertilization, pesticide use, irrigation-return practices, and some INEEL waste-disposal practices such as injection wells and percolation ponds. As urbanization increases in areas like Idaho Falls and Pocatello, new threats to the aquifer may develop.

The distribution of geologic materials at the surface and in the subsurface is an important consideration for the remedial action selection process for two reasons. First, aquifer protection will be greatest in areas with large thicknesses of fine-grained, low-permeability, high-porosity sediments in the vadose zone. These types of sediments may minimize water and contaminant transport by slowing the movement of water and sorbing contaminants on mineral grain surfaces. Second, the seismic hazard is affected by the interlayered basalt and sediment and by the thickness of surficial sediment above bedrock. The stratigraphy is highly variable across the INEEL.

Major geologic units in the INEEL include basalt lava flows, fluvial sediments along the Big Lost River, lacustrine (lake) sediments in the northern and northeastern parts of the INEEL, sediments deposited in playas (ephemeral lakes that have water only during parts of the year or once in several years), and eolian sediments (windblown silt and sand).

Areas of thick sediment offer very good aquifer protection because of the extremely low permeability of the materials and the ability of clay minerals to inhibit migration of potential contaminants. Eolian (windblown) deposits composed mostly of silt (loess) and fine sand occur throughout the INEEL and the entire ESRP (Scott 1982; Kuntz et al. 1994). These deposits tend to subdue the rugged, irregular topography of the lava flow surfaces and furnish a suitable medium for vegetation growth.

Seismology of the INEEL is discussed in detail in Appendix B and is summarized here. Earthquake monitoring by the INEEL and other seismic networks show that the ESRP and adjacent parts of the nearby mountain ranges lie in a zone of very low seismicity, which occurs within a more seismically active zone. The active zone includes the Yellowstone Plateau and young faults terminating at the edges of the ESRP. During about 30 years of earthquake monitoring by the INEEL seismic network, only a few microearthquakes (magnitude less than 2) have occurred on or near the INEEL (Jackson et al. 1993). The largest recorded earthquake in the vicinity of the INEEL was the 1983 Borah Peak earthquake, magnitude 7.3, which was centered in the middle portion of the Lost River Fault near Mackay and Challis, about 80 km (50 mi) from the INEEL. Another large earthquake, the Hebgen Lake earthquake, occurred on Yellowstone Plateau in 1959, about 200 km (124 mi) from the INEEL. None of these earthquakes produced any damage on the INEEL. Seismic hazard assessment results have been used to identify INEEL seismic design criteria. These criteria are applied to the design of cleanup alternatives.

Volcanism on the INEEL is discussed in detail in Appendix B and is summarized here. Basalt lava flows, ranging in age from more than a million years to less than 15,000 years, cover most of the southern two-thirds of the Site. They generally lie in topographically high areas that stand above the Big Lost River floodplain. The volcanic vents for these lava flows occur in northwest trending volcanic rift zones and along the northwest trending axial volcanic zone. Basalt volcanism is the most significant volcanic hazard for the INEEL facilities, but the annual probability of inundation for any INEEL facility is estimated at about 1E-06 or less (Hackett et al. 2000). The probability drops rapidly with distance from volcanic rift zones. The potential for volcanism has, therefore, not been a consideration in identifying, selecting, or designing cleanup alternatives for the INEEL.

Four basic soilscapes exist at the INEEL: (1) windblown sediments (eolian) over lava flows, (2) river-transported sediments deposited on alluvial plains, (3) fine-grained sediments eroded into lake or playa basins (lacustrine), and (4) colluvial sediments (loose deposits of rock debris collected at the slope base) originating from bordering mountains.

Alluvial plains offer flat terrain, subsurface gravels that are relatively easy to excavate, increased moisture and associated higher soil productivity, and desirable animal habitat. Most of the facilities at the INEEL have been located within alluvial plains.

The lacustrine deposits generally consist of clayey, alkaline surface soils over stratified subsoils. Some of the "slick spot" soils in the ancestral lakebed contain high amounts of exchangeable sodium and are characterized by a lack of vegetation and cracked surfaces. The deposits near Test Area North (TAN) are generally quite saline and support a variety of salt-tolerant plant species.

Colluvial deposits are prevalent along the base of the mountainous slopes on the west side of the INEEL and surrounding the East and Middle Buttes. Generally, the soils in these deposits are gravelly. Very little information is available about the soils within these deposits, except that these soils are subject to erosion, have comparably short growing seasons, and are generally suitable for rangelands and wildlife.

2.5 Surface Water Hydrology

The INEEL is located within the Pioneer Basin, a closed surface drainage basin on the western boundary of the ESRP. Natural surface water near or on the INEEL consists of three streams draining intermountain valleys to the north and northwest of the Site: the Big Lost River, Birch Creek, and the Little Lost River. Stream flows are often depleted before reaching the INEEL by irrigation and hydropower diversions, as well as infiltration losses along the channel beds. Surface water flows on the

INEEL either infiltrate into the ground or evaporate. There are no recreational or human consumptive uses of this surface water.

The Big Lost River is the major surface water feature on the INEEL. Its waters drain the northeastern portion of the Pioneer Range and southwestern portion of the Little Lost River Range. When flow in the Big Lost River reaches the INEEL, it is either diverted at the INEEL diversion dam near the Radioactive Waste Management Complex (RWMC) to the spreading areas (a series of four natural depressions) or flows northward across the INEEL. All flow of the Big Lost River that enters onto the INEEL, except for evaporation losses, is recharged to the subsurface. Groundwater recharge from the Big Lost River can be very pronounced in the SRPA and in perched groundwater.

The need for flood control on the INEEL was first recognized in the early 1950s when downstream facilities (Test Reactor Area [TRA] and INTEC) were threatened by localized flooding because of ice jams in the Big Lost River. The INEEL diversion dam was constructed in 1958 to divert high runoff flows from downstream INEEL facilities.

Flooding on the INEEL is discussed in detail in Appendix B and is summarized here. Areal extent of flooding, flood water velocities, and standing water depths resulting from a 100-year flood are typically used as criteria in selecting, locating, and designing cleanup alternatives. The 100-year flood represents the maximum flow likely to recur with a frequency of once in 100 years. Several studies have estimated the magnitude of the 100-year flood for the Big Lost River. The 100-year flood study for the Big Lost River, at a gauging station near Arco, 22.5 km (14 mi) upstream from the INEEL diversion dam, estimated flow at 105 m^3/s (3,700 cfs) to 125 m^3/s (4,400 cfs), based on a log-Pearson Type III distribution of historical stream gauging records (Tullis and Koslow 1983; U.S. Army Corp of Engineers 1991; Stone et al. 1992). Another study used a log-Pearson Type III distribution for a station upstream of Mackay Reservoir combined with a regional regression approach for 22 subbasins and an estimated peak flow of 204 m^3/s (7,200 cfs) for the 100-year flood for the Big Lost River at the Arco station (Kjelstrom and Berenbrock 1996). This estimate is believed to be conservatively high. The highest recorded flow at the Arco station was 125 m^3/s (1,890 cfs) in July 1967. A recent study using paleohydrologic data collected from several streams reaches along the Big Lost River below the Arco station, combined with historical stream gage data from the Arco station and a Bayesian flood-frequency analysis, estimated a flow of 94 m^3/s (3,300 cfs) for the 100-year flood for the Big Lost River at the Arco station (Ostenna et al. 1999). This latest study, which combines historical streamflow data with paleohydrologic field study sites along the Big Lost River, provides the best estimate of the 100-year flood to date. Therefore, a reasonable estimate of the 100-year flood for the Big Lost River at Arco is considered to be 94 m^3/s (3,300 cfs). The resulting areal extent of flooding, flood water velocities, and standing water depths for this scenario are used as criteria in selecting, locating, and designing cleanup alternatives for OU 10-04.

2.6 Subsurface Hydrology

This section describes the vadose zone, perched water bodies, and the groundwater at the INEEL.

2.6.1 Vadose Zone

The vadose zone is the region of the subsurface that extends from land surface to the water table. It is a particularly important component of the INEEL hydrologic system. The thick vadose zone affords protection to groundwater by acting as a buffer or filter, thus slowing or preventing many contaminants from reaching the SRPA. Water is the primary mechanism for most chemical transport in the vadose zone, although vapor transport can be significant for volatile constituents.

Sediment grain size controls the infiltration rate of water moving from land surface to the subsurface. If the grain size is relatively large at land surface, there can be rapid migration of water into the subsurface. At the INEEL, vadose zone soils tend to be relatively dry during most of the year near land surface because of the relatively low annual precipitation, high potential evapotranspiration, and deep water table.

Water can move rapidly through surficial sediments if the geologic media is coarse and there is sufficient moisture to wet the sediments. The moisture movement depends on the amount of infiltrating water, the moisture content, and hydraulic conductivity of the materials. The same material features (e.g., open fractures and large pores within the basalt) that contribute to rapid flow during saturated conditions impede moisture movement under unsaturated conditions.

2.6.2 Perched Water

Perched water bodies may form when a sufficient quantity of water moves downward through a higher conductivity zone and encounters a lower conductivity zone. Perched water zones have been identified at TRA, INTEC (formerly known as the Idaho Chemical Processing Plant [ICPP]), TAN, RWMC, and areas adjacent to the Big Lost River. Sources of water that can form or may have formed perched water within the vadose zone include past wastewater disposal to injection wells, percolation ponds, ditches, leaks in facility piping systems, surface ponding of water from snowmelt, and groundcover irrigation. The presence of perched water can increase flux rates, form preferential flow paths, and allow for more dissolution of contaminants.

2.6.3 Snake River Plain Aquifer

The SRPA is approximately 320 km (200 mi) long and varies in width from 48 to 97 km (30 to 60 mi). The aquifer extends in Idaho from near Ashton to the Thousand Springs area near Twin Falls and is bounded by the relatively less permeable rocks of the bordering mountains. The SRPA is one of the most productive aquifers in the United States. The EPA has designated the SRPA as a "sole source aquifer." The SRPA serves as the drinking water supply source for much of southeastern Idaho.

Groundwater in the SRPA has the large potential for water resource development for almost any purpose. The high transmissivity and fast flow rates make it ideal for large-scale water usage.

The fractured nature of the aquifer, great depths to the aquifer, high transmissivity and fast flow rates make it difficult to detect low concentrations of contaminants and determine flow directions over small areas.

2.7 Cultural Resources

Cultural resources are numerous on the INEEL and within WAGs 6 and 10 (Pace 2000). Resources that have been identified include archaeological sites, contemporary historic sites, and Native American cultural sites. Many of these resources are eligible for nomination to the National Register of Historic Places. One property, EBR-I within WAG 6, has been designated as a National Historic Landmark for its important contributions to the development of nuclear science and technology.

Over the past two decades, detailed inventories of archaeological sites have been assembled for some parts of the INEEL. Most of these survey efforts have focused on areas within and around major operating facilities and proposed future construction areas. As of January 1999, approximately 7.5% of the INEEL (17,400 ha; 42,962 acres) had been systematically surveyed and 1,884 significant archaeological localities ranging in age from 12,000 to 50 years had been identified.

Inventories of contemporary historic resources important for their association with World War II, the Cold War, and U. S. nuclear science and technology have also been initiated. Reconnaissance surveys have been completed for all buildings currently under DOE-ID administration and are in progress at the Naval Reactors Facility and Argonne National Laboratory-West (ANL-W). Among the hundreds of buildings surveyed, 217 have been determined to be historically significant.

Far less is known about the nature and distribution of Native American cultural resources at the INEEL. However, ongoing consultation and cooperation under the Agreement in Principle between DOE-ID and the Shoshone-Bannock Tribes (DOE-ID 2000) has shown that many archaeological sites located on the INEEL are regarded as ancestral and important to tribal culture. Natural landforms and native plants and animals in the INEEL region are also of sacred and traditional importance.

In an effort to enhance understanding of Shoshone-Bannock resources and concerns within OU 10-04, WAG 10 consulted directly with the Tribes to provide unique input for this document. Since 1996, the Shoshone-Bannock Tribal Risk Assessment Committee, composed of a coordinator, approximately 25 Tribal Elders, a five-person steering committee, a program manager, and three consultants (science advisor, two language advisors), has been working on risk-related issues pertaining to tribal resources and concerns. In February 2000, under a Purchase Order issued by DOE-ID, the Tribal Committee began an analysis of the WAG 6 and 10 sites of concern addressed in this document. To facilitate this analysis, WAG 10 hosted two field tours to the INEEL, gave a variety of slide presentations at Fort Hall, and provided many sources of written information. The general concerns identified by the Tribal Committee are contained in site-specific discussions to follow and the actual report prepared by the Tribes is included as Appendix A.

2.8 Flora and Fauna

The following sections describe the flora classes and fauna types as well as the threatened and endangered species generally located at the INEEL and specifically found in the vicinity of WAGs 6 and 10.

2.8.1 Flora

Fifteen cover classes of vegetation have been identified using satellite image analysis (Kramber et al. 1992). The classes are juniper woodlands, steppe, sagebrush-steppe off-lava, sagebrush-steppe on-lava, sagebrush/winterfat, sagebrush-rabbitbrush, sage/low-sage/rabbitbrush off-lava, salt desert shrub, steppe-small sagebrush, grassland, basin wildrye, wetlands, old field-disturbed seedings, lava, and playa-bareground/gravel-borrow pits. Some salient facts about some of these classes are:

- INEEL grasslands are variable, but are dominated by perennial grasses. Crested wheatgrass has been used to revegetate disturbed soils on the INEEL, in combination with other perennial grasses. Crested wheatgrass is somewhat more fire-resistant than native grasses because it remains green longer through the growing season (Anderson et al. 1991). It is much more fire-resistant than cheatgrass, a principal nonnative invader of disturbed soils on the SRP. Therefore, crested wheatgrass is regarded as a relatively fire-resistant species.[1] Crested wheatgrass meets other functional requirements of ground cover because:
  - It is relatively easy to establish on disturbed sites.

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[1] Jay Anderson, Roger Blew, personal communication

- Once established, the stands are resistant to invasion by other species.

- Crested wheatgrass is more drought-tolerant than most native grasses.

However, introduced stands of crested wheatgrass have been observed to spread and displace native plants. Crested wheatgrass is not currently used to revegetate disturbed or burned sites as extensively as in the past, and native species are being used to replant these types of areas wherever possible.[2]

- Wetlands are only found in one area at the INEEL: around the Big Lost River sinks. These areas are periodically flooded during years of high precipitation. Species diversity of these wetlands is very low.

- The lava cover class occasionally has junipers associated with it. The cracks, crevices, and cliffs also provide habitat for raptors, small and large mammals, and reptiles. There is also a greater probability for archaeological finds in these areas.

2.8.2 Fauna

The INEEL is home to and visited by a wide variety of species including two amphibians, six fish, 10 reptiles, 184 birds, and 37 mammals. Certain areas of habitat are relatively undisturbed due to the restricted public access within the INEEL boundaries. This has led to a richness of species with the possibility of other species present but not yet recorded.

2.8.3 Threatened, Endangered, and Sensitive Species

A comprehensive list of plant and animal species from federal and state threatened, endangered, and sensitive lists is presented in Appendix F. Although species of special concern and sensitive species do not receive legal protection, they are included here because of their presence at the INEEL.

Three comprehensive surveys of rare vascular plants at the INEEL have been conducted through the years. These extensive studies have identified seven sensitive plants known to occur at the INEEL and one Federal Candidate species found on Big Southern Butte.

Sticky phacelia (*Phacelia inconspicua*) is the plant species on the Federal Candidate List. Plains orophaca (*Astragalus gilviflorus*) is categorized as State Priority List 1 being in danger of becoming extinct or extirpated from Idaho in the foreseeable future. Spreading gilia (*Ipomopsis polycladon*) is on the State Priority List 2 and is in danger of becoming Priority 1 if factors contributing to its population decline or habitat degradation or loss continue. Three species are considered State Sensitive: Lemhi milkvetch (*Astragalus aquilonius*), wing-seeded evening-primrose (*Camissonia pterosperma*), and Oxytheca (*Oxytheca dendroidea*). These species could be downgraded to Priority 1 or 2 without active management or the removal of threats. Nipple coryphantha (*Escobaria missouriensis*) and Puzzling halimolobos (*Halimolobos perplexa* var. *perplexa*) are both on the State Monitor List making them uncommon on the INEEL, but with no identifiable threats.

The only animal species at the INEEL currently recognized as threatened or endangered under the Endangered Species Act are the bald eagle, a winter visitor, and the peregrine falcon. The bald eagle was

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[2] Jay Anderson, Roger Blew, personal communication

recently downgraded from endangered to threatened. The peregrine falcon remains endangered. The ferruginous hawk, white-faced ibis, black tern, northern goshawk, pygmy rabbit, and the Townsend's big-eared bat are all candidates for the Federal list. These candidate species are those for which the Fish and Wildlife Service has information suggesting that a change in status to threatened or endangered may possibly be appropriate, but for which conclusive data are not available.

2.8.4 Other INEEL Specific Issues

The INEEL is considered an ecological treasure (Anderson 1999). A special benefit of the site being set aside for government use was the protection of what now is arguably the largest expanse of protected sagebrush-steppe habitat outside the National Parks in the U.S. Approximately 40% of the INEEL, or 92,100 ha (227,5000 acres), has not been grazed for the past 45 years. Recognizing the importance of this undisturbed area as an ecological field laboratory, the area was designated as a National Environmental Research Park (NERP) in 1975. In addition, the DOE Secretary signed an agreement July 17, 1999 with the Bureau of Land Management, the U.S. Fish and Wildlife Service, and the Idaho Fish and Game Department, to establish the INEEL Sagebrush Steppe Ecosystem Reserve. The reserve includes approximately 29,950 ha (74,000 acres) of high-desert land. The U.S. Geological Survey (USGS) evaluated endangered ecosystems (Noss et al. 1997) and listed both ungrazed sagebrush steppe in the Intermountain West, and Basin big sagebrush (*Artemisia tridentata*) in the Snake River Plain of Idaho as ecosystems that are critically endangered (>98% decline).

Several wildlife species are found only or primarily in sagebrush habitats throughout their range. About 100 bird, 70 mammal, and 23 amphibian and reptile species in the Great Basin rely to some degree on sagebrush habitat for shelter and food. Some are sagebrush obligates—sagebrush lizard, pygmy rabbit, pronghorn, sage sparrow, brewer's sparrow, sage grouse, loggerhead shrike, and sagebrush vole that cannot survive without plenty of high-quality sagebrush and its associated perennial grasses and forbs. Other species depend on sagebrush for a significant portion of their diet. For example, pronghorn depend on sagebrush for nearly 90 percent of their diet (Lipske 2000).

Currently, a 1999 report prepared by the Western Working Group of the International Bird Conservation Coalition Partners in Flight warns that more than 50 percent of shrubland and grassland bird species in the Intermountain West show downward population trends. Sage grouse numbers have dipped more than 33% in the last 15 years, according to BLM studies. There is discussion on placing the sage grouse on the threatened and endangered list. Because the listing has not occurred, the sage grouse is not assessed as a species with special status in this RI/FS. If it or some other species is later added to a special status listing, then this will be addressed in the 5-year review.

2.9 Demography and Land Use

2.9.1 Demography

Five counties border the INEEL. Populations potentially affected by WAG 6 and 10 activities include government, contractor, and subcontractor personnel employed at the INEEL; Shoshone-Bannock Tribal members whose aboriginal homelands included the INEEL area; ranchers who graze livestock in areas on or near the INEEL; occasional hunters on or near the INEEL; highway travelers; and residential populations in neighboring communities. No resident populations are located within the INEEL site boundary, and no residents are located within the INEEL site boundary. Section 2.9.1 is provided as an overview of demographics. Further discussion on the demographics is included in Appendix B. It was previously decided that a regional approach would not be used as part of the risk assessment for ecological concerns because offsite monitoring and surveillance has ensured that risk to offsite is not an issue.

The nine separate INEEL facilities include approximately 450 buildings and more than 2,000 support facilities. Facilities within WAGs 6 and 10 are nearly all on inactive status. The only employees who regularly work there are tour guides who escort visitors through the EBR-I Visitors Center from Memorial Day to Labor Day.

2.9.2 Land Use

The BLM classifies INEEL land as industrial and mixed use (DOE-ID 1995). The current primary INEEL land uses are related to nuclear research, environmental engineering, protection, and remediation as well as waste management and minimization. Following are some pertinent facts about current land use:

- Large tracts of relatively undisturbed land are reserved as buffer and safety zones around each of the main facility areas on the INEEL.

- The relatively undisturbed and undeveloped buffer zones are currently used for environmental research, ecological preservation, sociocultural preservation, and grazing (DOE-ID 1997).

- Approximately 1,295 km^2 (500 mi^2)/121,410–141,645 ha (300,000–350,000 acres) of the buffer zone is used as grazing land for cattle and sheep (DOE-ID 1995). Grazing is not allowed within 3.2 km (2 mi) of any nuclear facility, and dairy cattle are not permitted.

- Depredation hunts, managed by the Idaho Department of Fish and Game, are permitted on-Site during selected years.

- An Agreement in Principle between the DOE-ID and the Shoshone-Bannock Tribes promotes Tribal involvement in a wide variety of DOE activities (DOE 2000), and a Memorandum of Agreement (DOE-ID 1994) authorizes tribal access to certain traditional use areas on the INEEL for the performance of Tribal sacred or religious ceremonies or other cultural or educational activities (DOE-ID 1992).

- The general public uses a total of 145 km (90 mi) of paved highways that pass through the INEEL (DOE-ID 1995) and currently has access to the Visitors Center at the EBR-1 National Historic Landmark. The Union Pacific Railroad also traverses the southern portion of the Site passing through 23 km (14 mi) of INEEL lands.

- In the counties surrounding the INEEL, approximately 45% of the land is agricultural, 45% is open land, and 10% is urban (DOE-ID 1995). Private individuals or the U.S. government owns most of the land directly adjacent to the INEEL boundary. The BLM administers most of the U.S. government property in the area.

Future land use is addressed in the INEEL future land-use scenarios document (DOE-ID 1995) and in the INEEL Comprehensive Facility and Land Use Plan (DOE-ID 1997). The following assumptions for the INEEL apply to OU 10-04:

- The INEEL will remain under government ownership and control for at least the next 100 years.

- The life expectancy of current and new facilities is expected to range between 30 and 50 years.

- No residential development (e.g., housing) will occur within the INEEL boundaries for the next 100 years.

- No new major, private developments (residential or nonresidential) are expected in areas adjacent to the INEEL.

Generally, future land use within the INEEL is expected to remain essentially the same as current use. That is, the INEEL is likely to continue as an industrial and research facility (DOE-ID 1997), with moderate growth expected for the next two decades. Local Native American populations will continue to maintain an interest in the natural and cultural resources located there. Specific future uses of WAG 10 will likely include limited grazing, industrial uses, Native American traditional activities within selected areas, and limited hunting. Within WAG 6, the EBR-I site will remain recreational and industrial and the BORAX site will remain industrial for a minimum of 100 years.

2.9.3 Water Use and Supply

Production wells to the SRPA are the source of all water used at the INEEL.

Upstream of the INEEL, the Big Lost River, Little Lost River, and Birch Creek are used as sources of water for agriculture. The surface water that reaches the INEEL is not used for any purpose. No surface-water streams flow off the INEEL with the potential exception of diverted water exiting Spreading Area D during extremely wet or high water conditions.

Drinking water in the region is obtained almost exclusively from the aquifer.

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